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*SPECIALIZATION IN SCIENTIFIC  
STUDY.*

THERE ONCE was a science called 'natural philosophy,' which, like some old synthetic types of animals, held in itself all the learning that applied to physical facts. By the beginning of this century this science of natural things had become divided into physics and natural history. These divisions have since spread, like the divisions of a polyp community, until now natural history has more than a dozen named branches; and in physics the divisions are almost as numerous. There are now at least thirty named and bounded sciences; each name designating a particularly limited field, in which there are able men who work their days out in labor that does not consider the rest of man as having any relation to their work.

This progressive division of labor follows a natural law: and it is perhaps fit that science should itself give a capital illustration of the application of this law to forms of thought, as well as to the more concrete things of the world; but it is an open question whether or no it is advantageous to the best interests of learning. There can be no question that the search for truth of a certain quality is very greatly helped by this principle of divided labor. If a man wish to get the most measurable yield out of the earth in any way, the best thing for him is to stake off a very small claim, tie himself down to it, fertilize it highly, till it incessantly, and forget that there are blossoms or fruit beyond his particular patch; for any moment of consciousness of such impracticable things as grow beyond his field is sure to find its expression when he comes to dig his crop, whether his crop in the intellectual field be elements or animals, stars or animalculae. The harvest of things unknown is most easily won in this kitchen-gardening way of work.

The world needs, or fancies that it needs, this kind of work; and it is now of a mind to pay more of its various rewards for the least bit of special and peculiar knowledge than for the widest command of varied learning. In a thousand ways it says to its students, not only

as of old, "Study what you most affect," but, "*Effect that study altogether*, know the least thing that can be known as no one else knows it, and leave the universe to look after itself."

This is the prescription of our time. We are now proceeding on the unexpressed theory, that, because no man can command the details of all science, therefore he shall know only that which he can know in the utmost detail. We seem to be assuming, that, if many separate men each know some bit of the knowable, man in general will in a way know it all; that when, in another hundred years of this specialization, we have science divided into a thousand little hermit-cells, each tenanted by an intellectual recluse, we shall have completed our system of scientific culture. No one can be so blind to the true purposes of learning as to accept this condition of things as the ideal of scientific labor. It may be the order of conquest, the shape in which the battle against the unknown has to be fought; but beyond it must lie some broader disposition of scientific life,—some order in which the treasures of science, won by grim struggle in the wilderness of things unknown, may yield their profit to man.

The questions may fairly be asked, whether we have not already won enough knowledge from nature for us to return, in part, to the older and broader ideal of learning; whether we may not profitably turn away a part of the talent and genius which go to the work of discovery to the wider task of comprehension; whether we may not again set the life of a Humboldt along with the life of a Pasteur, as equally fit goals for the student of nature.

Until we set about the system of general culture in science, it will be nearly impossible to have any proper use of its resources in education. A sound theory of general culture in science must be preceded by a careful discussion of the mind-widening power of its several lines of thought. This determination cannot be made by men versed only in their own specialties: it must be made by many efforts to determine by comparison what part of the sciences have the most important power of mind-

developing. At present there are few men whose opinion on such a subject is worth any thing, and the number constantly grows less.

The greatest difficulty partly expresses itself in, and partly arises from, the multiplication of societies which include specialists as members, and specialties as the subjects of their discussions. We no longer have much life in the old academies, where men of diverse learning once sought to give and receive the most varied teaching. The geologists herd apart from the zoölogists: and in zoölogy the entomologists have a kingdom to themselves; so have the ornithologists, the ichthyologists, and other students. 'That is not my department,' is an excuse for almost entire ignorance of any but one narrow field. If naturalists would recognize this 'pigeon-holing,' not only of their work, but of their interests, as an evil, we might hope to see a betterment. Until they come to see how much is denied them in this shutting-out of the broad view of nature, there is no hope of any change. Special societies will multiply; men of this sort of learning will understand their problems less and less well; until all science will be '*caviare* to the general,' even when the general includes nearly all others beyond the dozen experts in the particular line of research.

The best remedy for this narrowing of the scientific motive would be for each man of science deliberately to devote himself, not to one, but to two ideals; i.e., thorough individual work in some one field, and sound comprehension of the work of his fellows in the wide domain of learning, — not all learning, of course, for life and labor have limits, but of selected fields. In such a system there will be one society-life meant for the promotion of special research, and another meant for the broader and equally commendable work of general comprehension.

It is in a certain way unfortunate that investigation is to a great extent passing out of the hands of teachers. This, too, is a part of the subdivision work; but it is in its general effects the most unhappy part of it. As long as the investigator is a teacher, he is sure to be kept on a wider field than when he becomes a solitary special worker in one department.

The efforts now being made for the endowment of research will, if successful, lead to a still further tendency to limit the fields of scientific labor. A better project would be to keep that connection between inquiry and exposition from which science has had so much profit in by-gone times.

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#### HIBERNATION OF THE LOWER VERTEBRATES.

IN a recent article in *Science*, I gave the details of a series of observations of the habit of hibernation as it occurs among our mammals, and endeavored to show that this habit was not so fixed and regular as is commonly supposed.

When we come to study, in their native haunts, our reptiles and other lower vertebrates, it will be found that the same is true of them also. For instance: the turtles, as a class, are supposed to hibernate; but this is not strictly true of all of them. There are nine species of these animals, more or less abundant, in my neighborhood. One, the common box-tortoise, is strictly terrene; while the others are either aquatic or semi-aquatic. The box-tortoise more regularly and systematically hibernates than do any of the aquatic species. After two or three hard frosts, it burrows quite deeply into the earth, and seldom quits its hiding-place until every vestige of winter has disappeared. The appearance of the box-tortoise is the best 'sign' of settled spring weather that I know, though it sometimes fails; but to assert that "tortoises creep deep into the ground, so as to completely conceal themselves from view when a severe winter is to follow," and that "they go down just far enough to protect the opening of their shells"<sup>1</sup> when it is to be mild, is nonsense. The water and mud turtles, of which I have carefully studied eight species, appear, on the approach of cold weather, to bury themselves deeply in the mud at the bottoms of ponds and streams, and to remain there until spring. This is the common impression; and a superficial glance at their haunts during the winter seems confirmatory of it. Is it, however, strictly true of these turtles? The habit of hibernating is at least affected very materially by the severity of the winter. Furthermore, in most ponds of any considerable extent, frequented by turtles, there are sure to be one or more deep holes wherein many of the

<sup>1</sup> Signal-service notes, No. ix.: Weather-proverbs. 1883.